Maryland Department of Natural Resources
Tidewater Ecosystem Assessment Division
580 Taylor Ave, D2
Annapolis, MD 21401

Toll Free in Maryland: 1-877-620-8DNR ext. 8630
Outside of Maryland: 410-260-8630

http://www.dnr.state.md.us/coastalbays

**Printed on Recycled Paper**

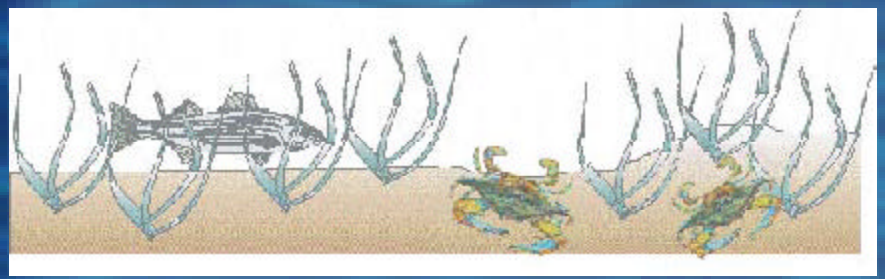




# Dissolved Oxygen in the Coastal Bays

Dissolved oxygen (DO) is needed by bay animals to live. Oxygen naturally dissolves into the water from the air at the bay surface and also through photosynthetic activity of aquatic plants (seagrasses) and algae (microscopic/phytoplankton and seaweeds/macroalgae) when light is sufficient. [Note: plants in the dark or plants which are shaded by docks or dirt in the water consume more oxygen then they can produce]. Currents and waves typically increase the amount of oxygen in the water. Oxygen is then removed from bay water through the activity of living organisms (respiration) and the decay of dead plants and animals (organic material).

Natural fluctuations in oxygen occur due to daily cycles in photosynthesis and respiration with highest oxygen concentrations during the day when photosynthesis is pumping oxygen into the water, and lowest in the early morning when only oxygen consuming activities have been going on for eight or more hours. The natural balance between oxygen production and respiration may be interrupted by the decomposition of large amounts of organic material, leaving the water severely depleted of oxygen. Since most of the decaying material falls to the bottom, this further reduces dissolved oxygen near the bottom. Organisms which can not move about easily will die. Fish and crabs generally detect and avoid areas with low dissolved oxygen. Oxygen concentrations that are avoided tend to be 2 - 3 times higher than lethal DO.



*Dissolved oxygen levels in the Coastal Bays are not always suitable for aquatic life.*

Dissolved oxygen levels in the Coastal Bays are not always suitable for aquatic life. **State water quality criteria requires a minimum DO concentration of 5 mg/l at all times**. This water quality standard is needed for the following aquatic target species: hard clam, alewife , blueback herring, white perch, striped bass (Funderburk *et al.* 1991). Blue crabs, bay anchovies, alewife, and blueback herring (juveniles) need a minimum of 3 mg/l, while spot and Atlantic menhaden, being the most tolerant of low oxygen, need a minimum of 2 mg/l and 1.1 mg/l, respectively, before significant mortalities occur (Funderburk *et al.* 1991). While these species may survive at such low oxygen values of 2 or 3 mg/l they will not grow or reproduce.

Background

Although the coastal bays are shallow lagoons which typically do not stratify (form layers that do not mix), oxygen values are frequently low in some areas. Observed low DO values are presumably due to the respiration of large algae blooms (caused by increased nutrient inputs), high sediment oxygen demand from organic enriched sediments due to runoff and decay of submerged aquatic vegetation, marsh vegetation, phytoplankton and macroalgae and/or poor circulation. A 1993 EPA study found bottom dissolved oxygen levels low enough to because for concern (DO < 5 mg/l) in 7% of the coastal bays during summer daylight hours (Chaillou et at. 1996). These conditions were most frequent in the dead-end canals and the St. Martin River. In fact, more than 55% of the area in dead end canals had bottom DO less than 5 ppm and more than 30% of that area had concentrations less than 2 ppm (Chaillou et at. 1996). These canals are

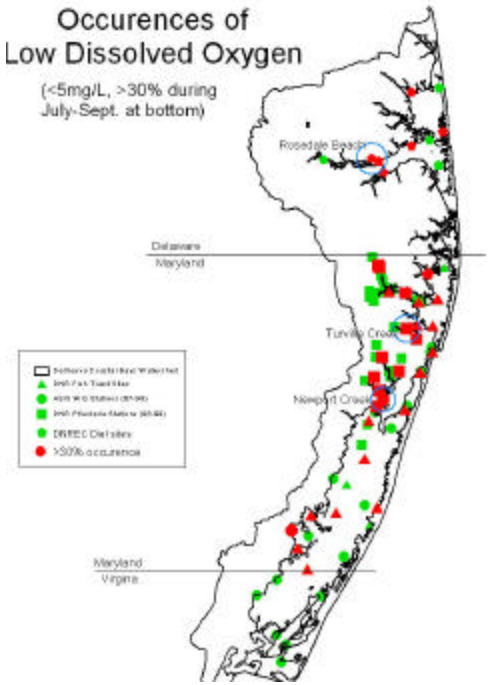



***Figure 1***

Lookdown


*References:*

Chaillou et. al. 1996, Assessment of the Ecological Condition of the Delaware and Maryland Coastal Bays, EPA/620/R-96/004.

Maryland Department of Natural Resources, Fisheries Service. Coastal Bays fisheries data 1994 - 1999.

Maryland Department of Natural Resources, Resource Assessment Service - Tidewater Ecosystem Assessment Division. Coastal Bays water quality data 1997 - 2002.

Funderburk, S.L.; S.J. Jordan; J.A. Milhursky, D. Riley. 1991 Habitat Requirements for Chesapeake Bay Living Resources. Second edition. Prepared by the Chesapeake Bay Program Habitat Objectives Workgroup of the Living Resources Subcommittee

Maryland Department of the Environment. 2000. Total Maximum Daily Loads of Nitrogen and Phosphorus for Five Tidal Tributaries in the Northern Coastal Bays System. Worcester County, Maryland. Md. Dept. of the Environment Report II, October 2000.

Maryland Department of the Environment. 2002. Total Maximum Daily Loads of Nitrogen for Three Tidal Tributaries and Total Maximum Daily Loads of Biochemical Oxygen Demand for One Tributary in the Newport Bay System. Worcester County, Maryland. Md. Dept. of the Environment Report II, December 2002

National Park Service, 2001. Assateague Island National Seashore, Bay Water Quality Report.

## Summary

A number of dissolved oxygen data sources show that Bishopville Prong, Shingle Landing Prong, areas of the St. Martin River, dead-end canals and some areas in Chincoteague Bay have poor fish and crab habitat (DO < 3 mg/L) during summer months. Furthermore, areas that have < 5 mg/L DO during the day may provide stressful habitat at night.

Hard Clam

typically deeper than the surrounding bays and circulation is poor. An analysis of historical data collected by the National Park Service Bay Water Quality Program (2001) and the Md. Department of Natural Resources, DNR, Coastal Bays Fisheries Monitoring Program (94-99) and DNRs Water Quality Monitoring Program (98-99) support that oxygen conditions are poor in the St. Martin River (Figure 1).

### Daytime Data

In the northern coastal bays, the Maryland Department of the Environment, MDE, reported 1998 daytime DO levels below the 5 mg/l standard were common throughout the year in some tributaries and were frequently below the state criteria during low flow months (July - October) in Bishopville Prong, areas of the St. Martin River mainstem, and Greys, Manklin, Herring and Turville Creeks (MDE 2000). The only areas that exhibited DO below 3 mg/l were Bishopville and Shingle Landing Prongs.

In the southern coastal bays, daytime DO levels were below standards throughout the Newport Bay region during the low flow months in 1998 (MDE 2002). DO levels in Ayer Creek have been observed below 2.5 mg/l. Kitts Branch data also show low levels of DO warranting a Total Maximum Daily Load for BOD. DO levels in Newport Creek frequently go below 5 mg/l. During the high flow months (November thru June) when temperatures and respiration are low, the DO levels are always observed above 5 mg/l.

Data collected by the Maryland Department of Natural Resources, Resource Assessment Service during 1999 through 2001 show that DO falls below 5 mg/l during the summer months in areas of the St. Martin River mainstem, Shingle Landing Prong,

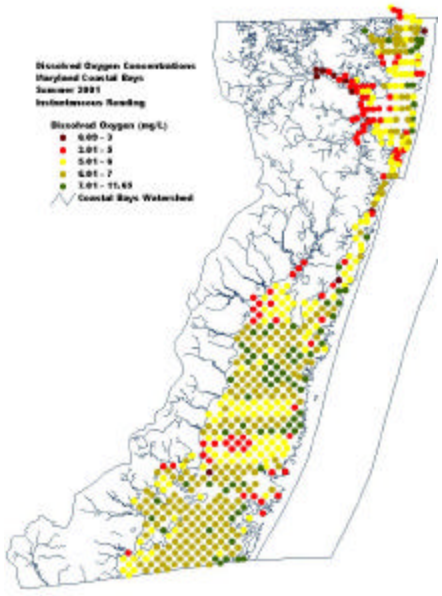


***Figure 2***

Bishopville Prong, Manklin Creek, Herring Creek, Turville Creek and throughout the Newport Bay watershed. DNR Fishery Service data indicate that all trawl sites within the coastal bays had some DO values below 5 mg/l during 1998 and 2000. Daytime DO values in the open bays (Assawoman, Isle of Wight and Chincoteague) generally did not fall below 5 mg/l during 2001 (DNR RAS data). Fisheries data, which tend to be from areas >4 feet, showed all sites in Isle of Wight and Sinepuxent Bays and one site in Chincoteague went below 5. Measures of DO as part of an intensive macroalgae survey in August 2001 (Figure 2) also indicated that bottom DO was poor in St. Martin River, Manklin , Herring, Turville, Ayer, Trappe, Newport and Marshall Creeks as well as areas in Chincoteague Bay near Figgs Landing and Green Run Bay.

Daylight measures of low dissolved oxygen conditions give a limited picture of oxygen dynamics since the lowest dissolved oxygen levels are observed in the early morning. This diurnal depletion of DO is not observed in the routine data, which is typically collected at mid-day; therefore, continuous monitoring has been added in the coastal bays to better understand the daily conditions living resources face.

Nighttime Data

Natural diel (24 hour) cycles of DO in aquatic systems are attributed to the balance between production (photosynthesis) and respiration. In aquatic systems enriched with nitrogen and phosphorus (eutrophic), this cycle can reach extreme levels ranging from supersaturation to anoxia within a matter of hours. For example, if the daily range (maximum minus minimum) in a system is large and the daily mean level of oxygen is low, minimum values of DO will likely fall below critical habitat values during the night.

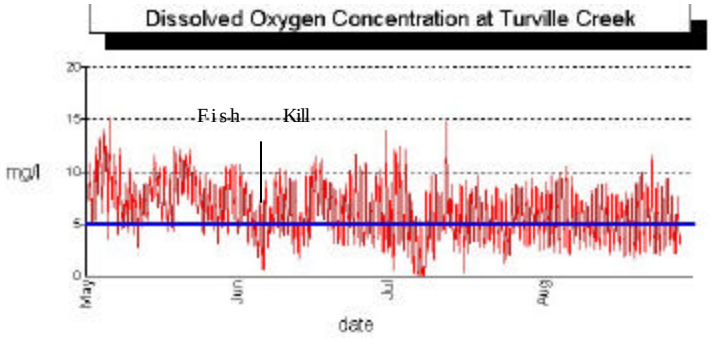



***Figure 3***

In 2001, continuous monitors were deployed for short periods in the coastal bays and in 2002 two long term continuous monitors were placed in Bishopville Prong and Turville Creek (Figure 3). Date from these monitors are available on the web at http://mddnr.chesapeakebay.net/NewMonTech/ContMon/current_results.cfm). Use of these new technologies lets us evaluate the health of the bays more closely. For example, data from the Turville site helped to show the ecological conditions that lead up to a fish kill. On June 7th, 2002, a fish kill of 15,000 menhaden was reported in the canals of Cape Isle of Wight. A nearby continuous monitor in Turville Creek showed that low dissolved oxygen of <1 mg/l on the morning of June 6th, caused by an algal bloom die-off several days prior, was the likely cause of the fish kill.

Daily oxygen ranges in the coastal bays vary between 1 and 6 mg/L/day depending on season and chlorophyll abundance. For example, in Chincoteague Bay ranges have been documented between 1 mg/L (max DO = 6.3 mg/l; min DO = 5.3 mg/l) in July to 6 mg/L in a seagrass bed near Tingles Island (max DO = 11 mg/l; min DO = 5 mg/l) in July. Daily ranges in August were between 3.87 mg/L in Manklin Creek (max DO = 6.4 mg/l; min DO = 1.25 mg/l) and 4.5 mg/L in Turville (max DO = 7 mg/l; min DO = 3 mg/l). Since these daily ranges are greater than 2 mg/L, areas that have 5 mg/L DO during the day can fall below 3 mg/L at night.

*All living things require oxygen to live.*